CEEP *PV PLANNER*© OVERVIEW

For over two decades, the Center for Energy and Environmental Policy (CEEP) has investigated the technical and economic feasibility of using solar electric power (provided by commonly termed 'photovoltaic' (PV) technology or 'solar cells'). CEEP has worked with the U.S. National Renewable Energy Laboratory (NREL) and others for 16 years on the development of *PV Planner*© software to analyze the benefits of PV technology. *PV Planner*© utilizes a vast quantity of data to model the physical, economic, financial and policy contexts specific to the area where the PV system is being installed.

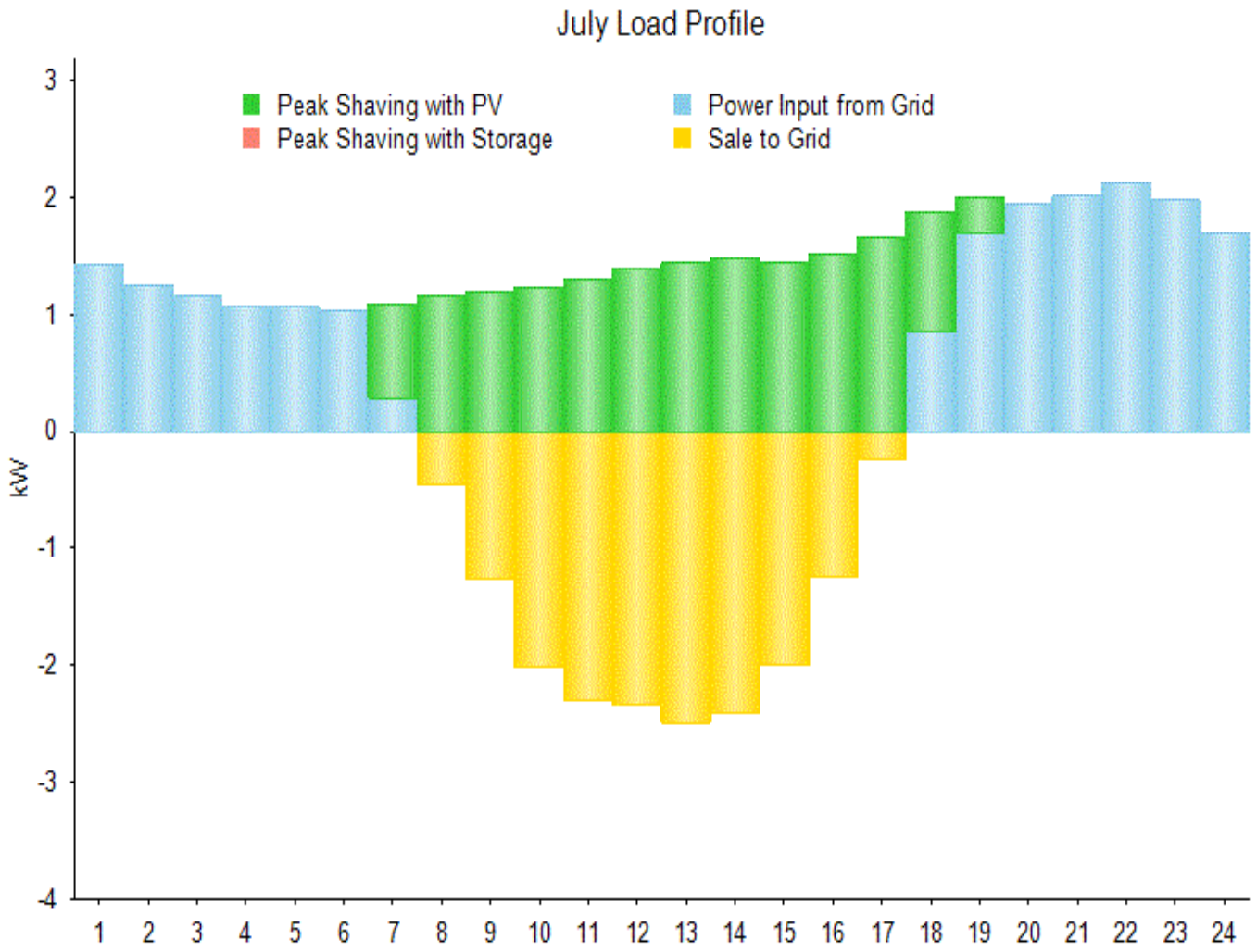
For U.S. applications, *PV Planner*© employs the Typical Meteorological Year 3 (TMY3) data set developed at NREL which relies upon over 1,000 weather stations across the U.S. to obtain temperature, insolation and other data relevant to the estimation of PV cell output. The performance of a PV system is reported using several metrics including present value, payback period, benefit-cost ratio, internal rate of return, cash flows and levelized costs. Because policy is constantly developing (particularly with the addition of new incentives to promote renewables), *PV Planner*© is regularly upgraded to reflect new policy measures.

CEEP has been able to demonstrate potential savings/benefits of PV systems under different configurations and policy options in several peer-reviewed, published papers, for locations in the U.S. (including Delaware) and abroad. Additionally, CEEP has modeled social and environmental co-benefits from the use of solar-generated electricity, including analyses of policy options to capture these co-benefits. Using *PV Planner*©, revenue streams from Solar Renewable Energy Credits (SRECs) and other policies (e.g., federal investment tax credit, rebates, the modified accelerated cost recovery system etc.) can be accurately accounted for in the financial analysis of PV system operations.

CEEP *PV PLANNER*© INPUTS

(Total Inputs ≈ 100)

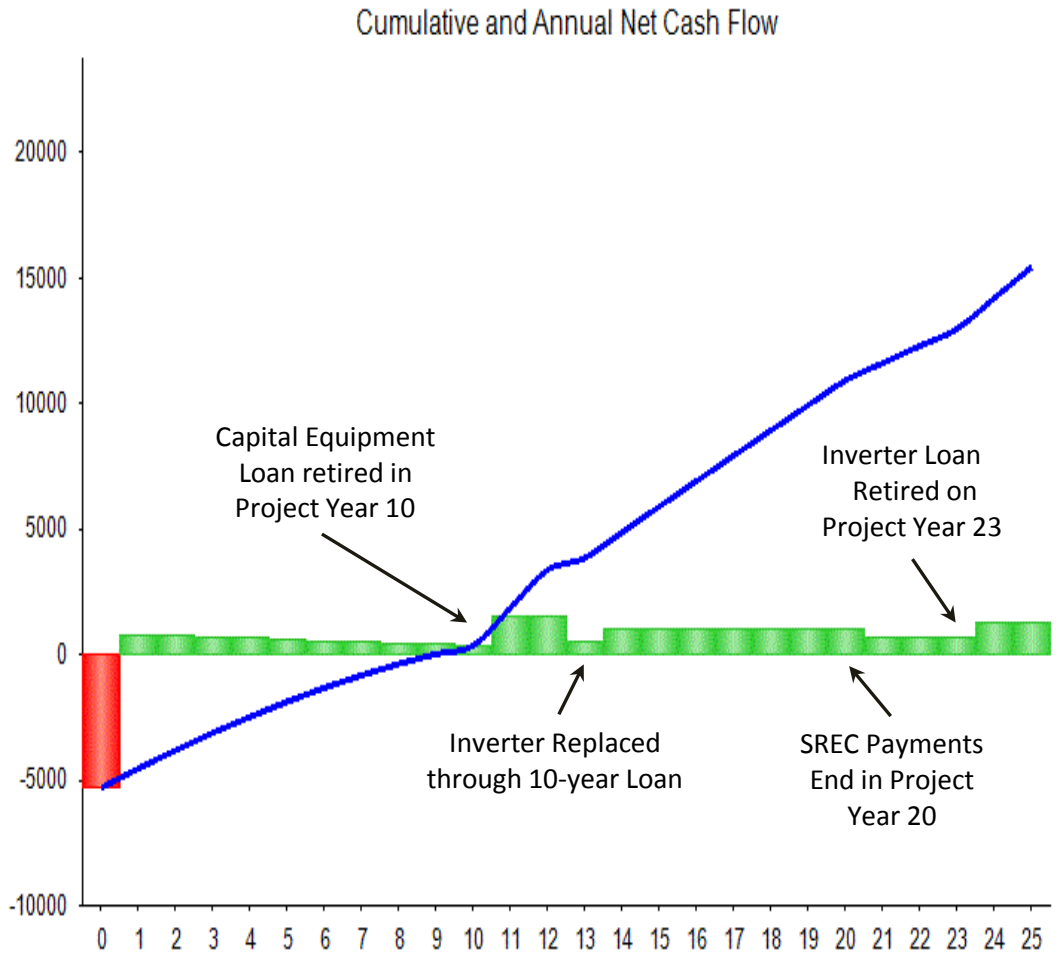
	List of Key Inputs	Tier 1	Tier 2
1.	Size of PV Array in kWp	7.5 kW_p	250 kW_p
2.	Type of Modules (Crystalline, Mono-crystalline, Amorphous)	Crystalline	Crystalline
3.	Annual Performance Degradation Rate	0.5%	0.5%
4.	Slope of Array	25°	10°
5.	Array Orientation	South	South
6.	Size of Inverter in kWp	7.5 kW_p	250 kW_p
7.	PV System Cost in $/Wp	$6,000	5,500
8.	Inverter Replacement Year	13	13
9.	Annual Maintenance Costs in $	$175	$1,000
10.	Annual Cost Escalation Rate in % [e.g., for Inflation adjustment]	2%	2%
11.	Inverter Replacement Costs in $/kW	$534	$534
12.	Share of Loan in the Capital Cost in %	80%	70%
13.	Loan Interest Rate in %	6%	6%
14.	Loan Duration in Years	10	10
15.	Share of Loan for Inverter Replacement in Year 13	80%	0%
16.	Discount Rate (same as cost of equity) in %	6%	10%
17.	Combined Incremental Federal and State Tax Rate %	33%	40%
18.	Capital Tax Depreciation Method	NA	MACRS 5-Yrs
19.	Evaluation Period in Years	25	25
20.	State or Local (e.g., municipal, utility) Rebates or Grants on Initial Cost of Capital in % or $/Wp State Tax Credits if any in %	$7,131	-
21.	Electricity Rates (cents/kWh)	14 cents/kWh	8.5 cents/kWh (PPA)
22.	Electricity Rates ($/kW)	-	-
23.	Electricity Rate Annual Rate Escalation	1%	1%
24.	Is Income from SRECs Taxable?	Yes	Yes
25.	SREC Price for 1st 10 Years ($/MWh)	290	270
26.	SREC Price for Year 11 through 20	50	50


July Load Profile
Peak Shaving with PV
Peak Shaving with Storage
Power Input from Grid
Sale to Grid
kW
3
2
1
0
-1
-2
-3
-4
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

Residential Rooftop Application: 7.5 kW_p
Initial Yearly Generation: 9,634 kWh

Year	Annual Net Cash Flow	Cumulative Cash Flow
0	($5,301)	($5,301)
1	$768	($4,534)
2	$729	($3,805)
3	$688	($3,117)
4	$645	($2,473)
5	$600	($1,873)
6	$552	($1,320)
7	$503	($818)
8	$450	($368)
9	$395	$28
10	$337	$365
11	$1,506	$1,871
12	$1,507	$3,379
13	$472	$3,851
14	$1,029	$4,880
15	$1,023	$5,903
16	$1,018	$6,921
16	$1,011	$7,932
18	$1,005	$8,937
19	$998	$9,935
20	$990	$10,925
21	$690	$11,615
22	$683	$12,298
23	$675	$12,973
24	$1,229	$14,202
25	$1,231	$15,434

* Undiscounted



CEEP *PV PLANNER*© SELECTED OUTPUTS
Commercial Rooftop Application (10^O tilt): 250 kW_p

Initial Yearly Generation: 308.5 MWh

Summary (Present Value)

Benefits		**Costs**	
Demand Bill Savings:	$0.00	Initial Net Capital Cost:	$851,230.04
Energy Bill Savings:	$247,099.29	O&M Cost:	$60,843.40
Energy Sale Revenue:	$0.00	Tax on Bill Savings:	$98,839.71
Tax Deduction:	$444,884.01	Tax on Sales to Grid:	$0.00
Emission Reduction Benefits:	$0.00	Tax on Rebates & RECs:	$234,724.01
RECs:	$586,810.02	Property Taxes:	$0.00
Total	$1,278,793.31	**Total**	$1,245,637.16

Financial Performance Indicators		**Levelized Cost of Electricity (LCOE)**	
Net Present Value (NPV):	$33,156.15	LCOE with Tax Deductions:	17.31 c/kWh
Internal Rate of Return (IRR):	13.78 %	LCOE with SREC Benefits:	4.26 c/kWh
Payback Year on Initial Capital:	9.21		
Payback Year on Equity:	2.71	SREC Break-Even Price in Yr 1:	267 $/MWh
Benefit Cost Ratio (BCR)	1.03		

First Year Result

Month	Original Demand (kW)	Original Energy (kWh)	Peak Shaving (kW)	Energy Savings (kWh)	Net System Energy Gen. (kWh)	Reverse Energy Flow (kWh)	Demand Bill Savings ($)	Energy Bill Savings ($)	Sales to Grid ($)
January	545.8	300,650	0.00	16,265	16,265	0	0	1,383	0
February	505.5	248,448	0.00	19,455	19,455	0	0	1,654	0
March	463.6	251,610	0.00	28,345	28,345	0	0	2,409	0
April	343.1	181,164	0.00	30,106	30,106	0	0	2,559	0
May	355.4	190,270	0.00	33,763	33,763	0	0	2,870	0
June	412.7	215,183	0.00	35,301	35,301	0	0	3,001	0
July	475.3	254,263	0.00	34,953	34,953	0	0	2,971	0
August	469.2	259,573	0.34	31,440	31,440	0	0	2,672	0
September	388.2	204,207	0.00	26,820	26,820	0	0	2,280	0
October	369.5	200,641	0.00	22,886	22,886	0	0	1,945	0
November	424.0	222,958	0.00	15,189	15,189	0	0	1,291	0
December	486.3	266,963	0.00	14,009	14,009	0	0	1,191	0
Total	5,238.6	2,795,930	0.34	308,533	308,533	0	0	26,225	0